Great Basin Naturalist 56(2), © 1996, pp. 162–166

POGONOMYRMEX OWYHEEI NEST SITE DENSITY AND SIZE ON A MINIMALLY IMPACTED SITE IN CENTRAL OREGON

Peter T. Soulé[1] and Paul A. Knapp[2]

ABSTRACT.—Little is known about the basic characteristics of the western harvester ant (*Pogonomyrmex owyheei*) in the absence of anthropogenic disturbances. We examined the role of *P. owyheei* as an agent of disturbance in an area of semiarid vegetation in central Oregon known as the Horse Ridge Research Natural Area (HRRNA) that has been largely free of livestock grazing and other significant anthropogenic influences for over 23 yr. We determined density and size characteristics of nest sites and estimated total area cleared by *P. owyheei* activities on HRRNA. From random sampling of twenty-five 0.04-ha plots we found a mean nest density/standard error of 1.6 (±0.16) nests/0.04 ha. Mean area cleared per nest site was 4.8 m^2, which results in an estimated barren area of 46,080 m^2 on the 240-ha HRRNA. Comparing our findings to others on *P. owyheei* and *P. occidentalis*, we found nest density and mean cleared area to be in the middle range of reported observations under a variety of land-use influences. The literature suggests that moderate disturbance may increase nest site density, but little relationship exists between disturbance history and mean size of nest sites.

Key words: Pogonomyrmex owyheei, *western harvester ants, nest density, nest size, vegetation clearing.*

Western harvester ants are a major component of arid rangeland ecosystems in the United States. Because of the combined effects of seed predation, seed dispersal, and vegetation removal, harvester ants are "keystone species," meaning their effects on vegetation structure and dynamics exceed expectations given their density and biomass (Holldobler and Wilson 1990: 616). The most visible impact of harvester ant activities is vegetation clearing around their nest sites. Although the size of the cleared area, or disc, varies, *Pogonomyrmex* harvester ants have the capacity to cut annual plants surrounding their nest sites at rates of over 200 million plants/ha/yr (Clark and Comanor 1975). While much of the plant biomass cut is not consumed by the ants, it reduces the total volume available for consumption by livestock and other grazers (Willard and Crowell 1965). Range managers have viewed *Pogonomyrmex* as pests that need to be controlled, giving the ant both economic and ecological importance in arid rangelands (Wight and Nichols 1966, Cole 1968).

Because of the paucity of undisturbed areas in the semiarid West, little is known about the basic characteristic of *P. owyheei* nest sites in the absence of anthropogenic disturbances. The primary objectives of this study are (1) to determine the density and size characteristics of *P. owyheei* nest sites and (2) to estimate the total area denuded by clearing and foraging activities of *P. owyheei* within a largely undisturbed semiarid ecosystem.

STUDY AREA

The Horse Ridge Research Natural Area (HRRNA) is a 240-ha exclosure 31 km southeast of Bend, Oregon, managed by the Prineville District, Bureau of Land Management (BLM). The natural area was established in 1967, and a surrounding fence was completed in 1974. The exclosure ranges from 1250 to 1430 m elevation over rolling topography of Columbia Basalts (Anonymous 1972). Direct human impacts on the site are minimal as there is only occasional use by hunters and naturalists, and fire suppression is not active (Halvorson 1991, R. Halvorson personal communication 1995). The fence has kept the area free of livestock grazing since 1974, but before its establishment the area apparently received minimal domestic animal grazing pressure because of a lack of a permanent water source to attract animals (Anonymous 1972) and the distance from well-traveled public roads (Baldwin 1974). Additionally, the abundance on HRRNA of threadleaved sedge (*Carex filifolia*), a species that has been shown to decline

[1]Department of Geography and Planning, Appalachian State University, Boone, NC 28607.
[2]Department of Geography, Georgia State University, Atlanta, GA 30303.

because of overgrazing in the central Oregon sagebrush steppe, and the absence of cheatgrass (*Bromus tectorum*) suggest a minimally disturbed site (Anonymous 1972, personal observation 1995).

Vegetation on HRRNA is classified as the western juniper/big sagebrush/threadleaved sedge community (*Juniperus occidentalis*/ *Artemisia tridentata*/*Carex filifolia*) (Franklin and Dyrness 1988). Less common but present species are bluebunch wheatgrass (*Agropyron spicatum*), Idaho fescue (*Festuca idahoensis*), junegrass (*Koeleria cristata*), and horsebrush (*Tetradymia glabrata*) (Anonymous 1972).

HRRNA climate is dominated by winter precipitation. Over half the annual 31 cm falls as snow. Mean temperatures at Bend range from −0.6 °C in January to 17.7 °C in July (Karl et al. 1990).

Soils on our study plots are entirely within the Stookmoor-Wesbutte complex soil series (USDA-NRCS in press). This soil series is found on approximately 85% of HRRNA. A typical soil profile is represented by a surface layer of mixed ash and loamy material approximately 15 cm thick, and a pale brown, sandy loam subsoil 46 cm deep overlying bedrock. Percentage of organic matter in the topsoil is 1%–2% and 0.5%–2% in the subsoil (USDA-NRCS in press).

Besides *P. owyheei*, there is disturbance pressure on HRRNA from grazing activities of herbivores and granivores such as Rocky Mountain mule deer (*Odocoileus hemionus hemionus*), badger (*Taxidea taxus*), and cottontail rabbits (*Sylvilagus nutalli*) (Gashwiler 1972, personal observation 1995). BLM records on HRRNA report no outbreaks of intense herbivory or episodes of pathogens causing severe plant losses in the last 20 years (R. Halvorson personal communication 1995).

METHODS

In roughly the center of HRRNA, a 19.6-ha permanent grid was established by Gashwiler (1977) for use in an ecological study in 1972. Stations on the 12 × 12 grid are marked by rebar stakes and spaced 40.2 m apart. Using this grid, we randomly selected 25 stations and established 0.04-ha circular plots from the rebar-marked center points for a total sample area of 1 ha. We tallied and measured each active *P. owyheei* nest site within each plot. We placed line transects over the center of each nest site and measured the cleared disc area in north-south and east-west directions. The edge of each disc was determined by the intersection of any perennial with the N-S or E-W transect lines.

RESULTS

There were 40 active *P. owyheei* nest sites in our 1-ha sample. We found nest sites on 23 of the 25 circular plots, and the maximum number of nest sites was 3 per 0.04 ha. Mean nest density/standard error was 1.6 (±0.16) nests/0.04 ha. Characteristics of the cleared discs are shown in Table 1. Assuming a circular shape, the mean area cleared per nest site is 4.8 m^2. Factoring in the nest density results in an estimated barren area of 192 m^2/ha, or 1.92% of the total land area of the permanent grid. If the influences of *P. owyheei* are consistent throughout the 240-ha HRRNA, then ant foraging and plant cutting surrounding a total of 9600 nest sites should leave approximately 46,080 m^2 of barren land on the 240-ha site.

DISCUSSION

The premise of this article is to provide information on *P. owyheei* nest site density

TABLE 1. Characteristics of *P. owyheei* nest sites on HRRNA.

Discs	Mean (cm)	Median (cm)	Maximum (cm)	Minimum (cm)	Standard deviation (cm)	*N*
N-S diameter	241.1	207.5	740	60	144.4	40
E-W diameter	254.6	220.0	670	68	156.8	40

TABLE 2. *Pogonomyrmex owyheei* and *P. occidentalis* nest site densities and mean size of nest site and estimated barren area due to *P. owyheei* and *P. occidentalis* activities reported in the literature.

Source	State	*Pogonomyrmex* species	Nest site density/ha	Nest site size in m^2	Estimated barren area %	Study site disturbance	Dominant vegetation
Sharp and Barr (1960)	Idaho	*owyheei*[a]	40	0.8	6.0	"misused/ depleted"	*Atriplex nuttallii / Halogeton glomeratus*
Sharp and Barr (1960)	Idaho	*owyheei*[a]	9	1.3	3.7	"vigorous stand"	*Atriplex nuttallii*
Sharp and Barr (1960)	Idaho	*owyheei*[a]	12	nr[b]	nr	not discussed	*Ariplex confertifolia*
Willard and Crowell (1965)	Oregon	*owyheei*	49–74	22.5	11–17	not discussed	*Bromus tectorum*
Wight and Nichols (1966)	Wyoming	*occidentalis*[d]	nr	65.7	nr	lightly grazed[c]	*Atriplex nuttallii*
Rogers and Lavigne (1974)	Colorado	*occidentalis*	23	1.2	0.3	ungrazed for 30 years	*Buchloe dactyloides / Bouteloua gracilis*
Rogers et al. (1972)	Colorado	*occidentalis*	28	0.7	nr	lightly grazed	*Buchloe dactyloides / Bouteloua gracilis*
Rogers et al. (1972)	Colorado	*occidentalis*	31	0.4	nr	moderate grazing	*Buchloe dactyloides / Bouteloua gracilis*
Rogers et al. (1972)	Colorado	*occidentalis*	3	0.6	0.02	heavy grazing	*Buchloe dactyloides / Bouteloua gracilis*
Clark and Comanor (1975)	Nevada	*occidentalis*	30–43	2.4–15.9	nr	varied—lightly grazed / recent burns	*Artemisia tridentata / Agropyron desertorum*
Sneva (1979)	Oregon	*owyheei*	32	9.3	3.0	grazed pasture/ no intensity specified	*Artemisia tridentata / Agropyron spicatum / Stipa thurberiana /*
Sneva (1979)	Oregon	*owyheei*	80	0.9	0.7	lightly grazed/ brush control 10 yr prior to study killed 95% of plants	*Artemisia tridentata / Agropyron spicatum / Stipa thurberiana / Bromus tectorum*
Sneva (1979)	Oregon	*owyheei*	57	1.5	0.8	lightly grazed/ brush control 22 yr prior to study killed 95% of plants	*Artemisia tridentata / Agropyron spicatum / Stipa thurberiana / Bromus tectorum*
Coffin and Lauenroth (1988)	Colorado	*occidentalis*	25	1.4	nr	moderately grazed	*Bouteloua gracilis*
Coffin and Lauenroth (1990)	Colorado	*occidentalis*	31	1.2	nr	lightly grazed	*Bouteloua gracilis*
Nowak et al. (1990)	Idaho	*owyheei*	nr	3.5	nr	no grazing or fire in 30+ yr	*Artemisia tridentata / Oryzopsis hymenoides*
Nowak et al. (1990)	Idaho	*owyheei*	nr	5.3	nr	burned 5 yr prior to sample, then ungrazed	*Artemisia tridentata / Oryzopsis hymenoides*

[a]Identified as *occidentalis*, but in the known range of *owyheei*
[b]Not reported
[c]All references to grazing refer to grazing of cattle or other livestock.
[d]*P. owyheei* was considered to be part of *P. occidentalis* until 1950.

and cleared disc size in an undisturbed area. Much of the information on areas cleared by *Pogonomyrmex* harvester ants relates to study sites with varying degrees of disturbance history. However, few studies examine the role of *P. owyheei* and *P. occidentalis* as agents of plant removal in undisturbed environments. In our study we briefly compare results of plant removal in undisturbed areas with those results presented elsewhere.

Our nest site density of 40/ha is in the approximate middle range of reported observations under a variety of land-use influences (Table 2). Disturbance may serve to increase the nest site densities at any given site up to a point. For example, Rogers and Lavigne (1974: 995) found an increase in nest site density under "light" and "moderate" grazing, but sharply reduced densities under "heavy" grazing. Findings of Sharp and Barr (1960) and Sneva (1979) also suggest increases in nest site density are associated with disturbance (Table 2). Across the range of *P. owyheei* and *P. occidentalis*, nest site densities are likely controlled by a suite of factors (soils, vegetation composition, climate, disturbance history) acting synergistically. Increases in nest site density in grazed areas probably result from alterations of the dynamics of competition between plant species that in turn modify seed density distributions

(Holldobler and Wilson 1990). On their study site in southern Arizona, for example, Davidson et al. (1984) found that harvester ant populations began to decrease approximately 2 yr after rodent populations were intentionally reduced. Davidson et al. (1984: 1780) concluded that rodent removal led to a "differential increase" in large-seeded annuals because of the cessation of granivory, and this in turn precipitated the competitive displacement of small-seeded species that were the ant's primary food source.

Although other studies have used larger sample sizes to determine nest density (e.g., Coffin and Lauenroth [1988] used a 2.5-ha sample), we believe our nest site density is a reasonable estimate for HRRNA because (1) the study site is consistent in regard to soils and vegetation, and has only minor topographic variability; (2) our standard error per sample for nest density is small, suggesting little variability within our study area; and (3) research from studies on other *Pogonomyrmex* species has shown that soil texture can affect nesting location (e.g., Johnson 1992, DeMers 1993), and that a uniform dispersion of ant colonies develops regardless of spatial scale examined (Wiernasz and Cole 1995). There appears to be little relationship between disturbance history and mean size of nest sites (Table 2). Sneva (1979) has speculated that while there may be great variability in nest site density and disc area, the potential available forage per nest site generally remains consistent, suggesting that vegetation cover and species composition can affect disc size. Soil characteristics also impact disc size, with a tendency for colonies to expand horizontally in shallow soils (Sneva 1979). Therefore, disc size may be largely linked to the amount of vegetation cover, plant species composition, and soil depth, and less influenced by disturbance than is nest density.

LITERATURE CITED

ANONYMOUS. 1972. Horse Ridge Research Natural Area. Federal Research Natural Areas in Oregon and Washington. Pacific Northwest Forest and Range Experiment Station, Portland, OR.

BALDWIN, E. M. 1974. Evaluation of Horse Ridge Natural Area, Deschutes County, region for eligibility for registered natural landmark designation. Supplemental Report, University of Oregon, Eugene.

CLARK, W. H., AND P. L. COMANOR. 1975. Removal of annual plants from the desert ecosystem by western harvester ants, *Pogonomyrmex occidentalis*. Environmental Entomology 4: 52–56.

COFFIN, D. P., AND W. K. LAUENROTH. 1988. The effects of disturbance size and frequency on a shortgrass plant community. Ecology 69: 1609–1617.

______. 1990. Vegetation associated with nest sites of western harvester ants (*Pogonomyrmex occidentalis* Cresson) in a semiarid grassland. American Midland Naturalist 123: 226–235.

COLE, A. C., JR. 1968. *Pogonomyrmex* harvester ants: a study of the genus in North America. The University of Tennessee Press, Knoxville. 222 pp.

DAVIDSON, D. W., R. S. INOUYE, AND J. H. BROWN. 1984. Granivory in a desert ecosystem: experimental evidence for indirect facilitation of ants by rodents. Ecology 65: 1780–1786.

DEMERS, M. N. 1993. Roadside ditches as corridors for range expansion of the western harvester ant (*Pogonomyrmex occidentalis* Cresson). Landscape Ecology 8: 93–102.

FRANKLIN, J. F., AND C. T. DYRNESS. 1988. Natural vegetation of Oregon and Washington. Oregon State University Press, Corvallis. 452 pp.

GASHWILER, J. S. 1972. List of birds, mammals, and plants found on Horse Ridge. Letter (12/27) to Paul W. Arrasmisth, Prineville, OR, BLM.

______. 1977. Bird populations in four vegetational types in central Oregon. Special Scientific Report—Wildlife No. 205. United States Department of Agriculture, Fish and Wildlife Service, Washington, DC.

HALVORSON, R. 1991. Natural ignition (fire) in Horse Ridge ACEC/RNA, concerns and challenges. Correspondence (9/16) to ADM–Resource Services, Prineville, OR, BLM.

HOLLDOBLER, B., AND E. O. WILSON. 1990. The ants. The Belknap Press, Cambridge, MA. 732 pp.

JOHNSON, R. A. 1992. Soil texture as an influence on the distribution of the desert seed-harvester ants *Pogonomyrmex rugosus* and *Messor pergandei*. Oecologia 89: 118–124.

KARL, T. R., C. N. WILLIAMS, JR., F. T. QUINLAN, AND T. A. BODEN. 1990. United States Historical Climatology Network (HCN) serial temperature and precipitation data. Carbon Dioxide Information Analysis Center, Oak Ridge, TN. 379 pp.

NOWAK, R. S., C. L. NOWAK, T. DEROCHER, N. COLE, AND M. A. JONES. 1990. Prevalence of *Orysopis hymenoides* near harvester ant mounds: indirect facilitation by ants. Oikos 58: 190–198.

ROGERS, L. E., AND R. J. LAVIGNE. 1974. Environmental effects of western harvester ants in the shortgrass plains ecosystem. Environmental Entomology 3: 994–997.

ROGERS, L. E., R. J. LAVIGNE, AND J. L. MILLER. 1972. Bioenergetics of the western harvester ant in the shortgrass plains ecosystem. Environmental Entomology 1: 763–768.

SHARP, L. E., AND W. F. BARR. 1960. Preliminary investigations of harvester ants on southern Idaho rangelands. Journal of Range Management 13: 131–134.

SNEVA, F. A. 1979. The western harvester ants: their density and hill size in relation to herbaceous productivity and big sagebrush cover. Journal of Range Management 32: 46–47.

USDA–NATURAL RESOURCES CONSERVATION SERVICE. In press. Upper Deschutes River Area, Oregon Soil Survey. USDA–NRCS, Washington, DC.

WIERNASZ, D. C., AND B. J. COLE. 1995. Spatial distribution of *Pogonomyrmex occidentalis:* recruitment, mortality and overdispersion. Journal of Animal Ecology 64: 519–527.

WIGHT, J. R., AND J. T. NICHOLS. 1966. Effects of harvester ants on production of a saltbush community. Journal of Range Management 19: 69–71.

WILLARD, J. R., AND H. H. CROWELL. 1965. Biological activities of the harvester ant, *Pogonomyrmex owyheei,* in central Oregon. Journal of Economic Entomology 58: 484–489.

Received 13 November 1995
Accepted 28 February 1996